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WATER RESOURCES COMMISSION
BUREAU OF WATER MANAGEMENT
MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Two Continuous-Flow Bioassays on the
*Pennwalt Chemical Company, West Plant Effluent
Riverview, Michigan
June 14-18, 1971

US EPA RECORDS CENTER REGION 5



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Introduction

A 20 hour and a 72 hour continuous-flow bioassay were conducted on the Pennwalt West Plant effluent to determine its toxicity to fathead minnows, Pimephales promelas. Pennwalt discharges treated wastes along with cooling water to Mongugan Drain. Mongugan Drain then enters the Detroit River downstream from the West Plant effluent.

Methods

The Michigan Water Resources Commission's mobile bioassay laboratory was used to conduct the study. The laboratory utilizes receiving water and industrial discharges to create continuous-flow test solutions which closely simulate the waste concentrations to be expected at various distances downstream from the discharge. A more detailed description of the methods employed in this bioassay appears as Appendix 1.

Dilution water used in this test was obtained from Pennwalt's intake on the Detroit River. Pennwalt uses this water in its cooling and fire systems in the plant. Previous to and during this test, chlorine was detected in this water supply, therefore, the dilution water had to be dechlorinated to insure survival of fish held in this water. Dechlorination was achieved by continuously adding a small amount of a 0.00625N sodium thiosulfate to the dilution water before it entered the test container.

Grab samples of the effluent and diluent were taken throughout the course of the study to monitor dissolved oxygen, pH, conductivity, temperature, alkalinity, hardness, and total residual chlorine (Appendix 2). These determinations were performed in the bioassay trailer by Water Resources Commission (WRC) personnel. More complete chemical analyses were made on the grab samples in the WRC Lansing Laboratory (Appendix 2).

An automated water quality monitor was operated during this study. This monitor continuously recorded pH, temperature and conductivity of the effluent and pH and temperature of the dilution water (Appendix 3).

The first bioassay (20 hours) had test concentrations ranging from 2.10 to 25.00 percent effluent. The second bioassay (72 hours) had test concentrations ranging from 0.42 to 5.00 percent effluent.

Test Results - First Bioassay

After 20 hours of exposure fathead minnows could not survive in a 4.15 percent concentration of effluent. Only 40 percent survival was noted in the 2.10 percent effluent concentration (Table 1). All of the control fish appeared to be in good physical condition.

Table 1. Percent survival of the fathead minnow after exposure to Pennwalt West Plant effluent.

Percent effluent	<u>Percent survival/exposure period</u>	
	20 hours	
25.00	all dead < 6 1/2 hours	
22.40	" "	" "
20.80	" "	" "
18.70	" "	" "
16.65	" "	" "
14.55	" "	" "
12.50	" "	" "
10.40	" "	" "
8.30	" "	" "
6.25	" "	" "
4.15	all dead < 20 hours	
2.10	40%	
0.00	100%	

During this exposure of fathead minnows to various concentrations of Pennwalts waste extreme changes were noted in the conductivity and pH of the waste (Appendix 3). Starting at 3:00 PM June 14, the pH went from 9.0 to 10.1 then dropped to 2.4 by 6:30 PM. the conductivity during this time period went from 500 μ mhos to 2000 μ mhos. A grab sample of the waste taken at 6:30 PM this same day failed to detect any high concentrations of toxicants. Due to the high mortality in the lowest effluent concentration another bioassay was started June 15 at 8:00 AM. Test concentrations in this bioassay ranged from 0.42 to 5.00 percent effluent.

Bioassay Results - Second Test

Fathead minnows subjected to the Pennwalt West Plant effluent for 72 hours incurred significant mortality in effluent concentrations as low as 2.91 percent effluent (Table 2).

Table 2. Percent survival of the fathead minnows after exposure to Pennwalt West Plant effluent.

Percent effluent	Percent survival/exposure period		
	24 hours	48 hours	72 hours
5.00	90	30	10
4.16	100	80	70 ¹
3.74	90	70	40
3.33	100	70	50
2.91	100	50	50
2.50	90	80	60
2.08	80	70	70
1.66	100	100	90
1.25	100	90	90
0.83	100	100	100
0.42	100	100	100
0.00 (control)	100	100	100

Note 1. Effluent tubes were plugged so fish were subjected lower effluent concentrations.

Fish exposed to concentrations above 1.66% exhibited sublethal effects or stress symptoms such as: erratic swimming, inability to keep their position in the water column and general physical appearance different from control fish. The TL-50 for 96 hours was approximately 2.91 percent effluent. Extreme changes in conductivity and pH were also noted during this test. The greatest mortality occurred June 16, at approximately 3:00 PM. At 2:00 PM the pH went from 8.2 to 9.2 then dropped to 2.3 by 5:30 PM. At 3:20 PM on June 16, an effluent grab sample was taken which contained 170 mg/l of ammonia-nitrogen. This extremely high concentration of ammonia-nitrogen with the radical pH change would account for the acute toxicity of Pennwalt's waste.

Discussion

The Pennwalt West Plant effluent is extremely toxic to fathead minnows. This toxicity in low effluent concentrations occurred when the pH would increase by one unit for approximately two hours then decrease to 2.5 in less than one hour. This increase in pH was accompanied by an increase in conductivity. The only effluent sample taken when the pH increase occurred showed 170 mg/l of ammonia-nitrogen present. The toxicity of ammonia-nitrogen increases with an increase in pH.

During this survey noticeable amounts of surface oil was observed where the Pennwalt effluent is discharged. Analyses of waste samples for extractable oils ranged from 1.6 to 4.6 mg/l.

The estimated average flow of Pennwalt's effluent during this survey was 5.9 million gallons per day (9.1 cfs).

Summary

1. Two continuous-flow bioassays were conducted on the Pennwalt Chemical Company West Plant effluent on June 14-18, 1971.
2. Fathead minnows could not survive in a 4.10 percent effluent concentration for 20 hours (first test).
3. After twenty hours of exposure only 40 percent survived the 2.10 percent effluent concentration. This was the lowest effluent concentration used in the first bioassay (first test).
4. During exposure of fathead minnows to various concentrations of Pennwalt's waste extreme changes were noted in the conductivity and pH of the waste (first test).
5. Fathead minnows subjected to the Pennwalt West Plant effluent for 72 hours incurred significant mortality in effluent concentrations as low as 2.91 percent effluent (second test).
6. Sublethal effects of the waste on fish were apparent in concentrations of waste as low as 2.08 percent (second test).
7. Extreme change in conductivity and pH were also noted during the bioassay (300 μ mhos to 5,000 μ mhos and 2.2 to 9.6 respectively) (second test).
8. At 3:20 PM June 16, 1971, ammonia-nitrogen was present in the effluent at a concentration of 170 mg/l (second test).
9. The erratic pH and high concentration of ammonia-nitrogen in the waste were the most probable causes of the observed toxicity (second test).
10. These bioassays show that Pennwalt's West Plant effluent is toxic to the aquatic environment.

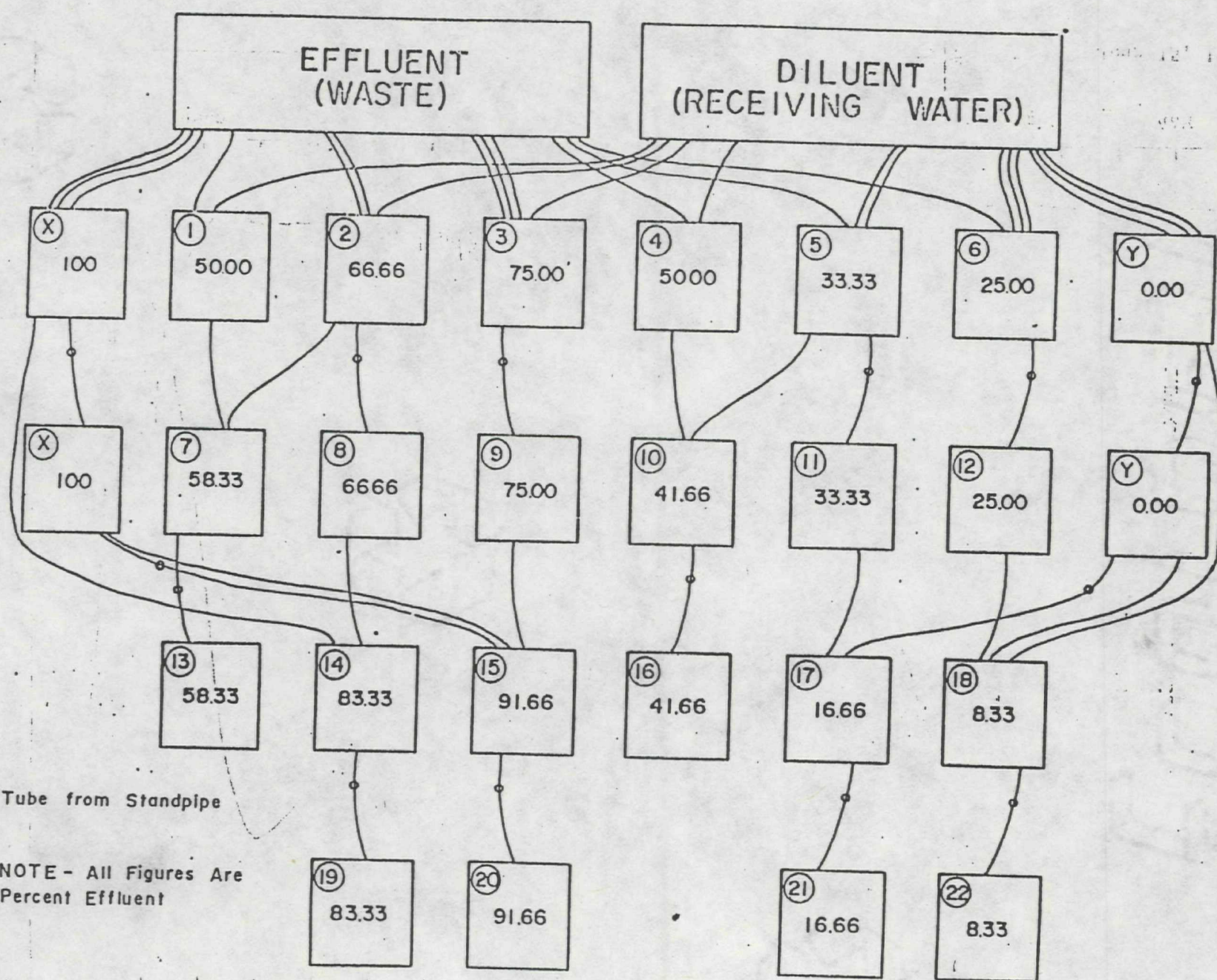
Field work by: George Jackson, Conservation Aide
Mark Wuerthele, Aquatic Biologist

Report by: Mark Wuerthele
Water Quality Appraisal Section
Water Resources Commission
Michigan Department of Natural Resources

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July 14, 1971

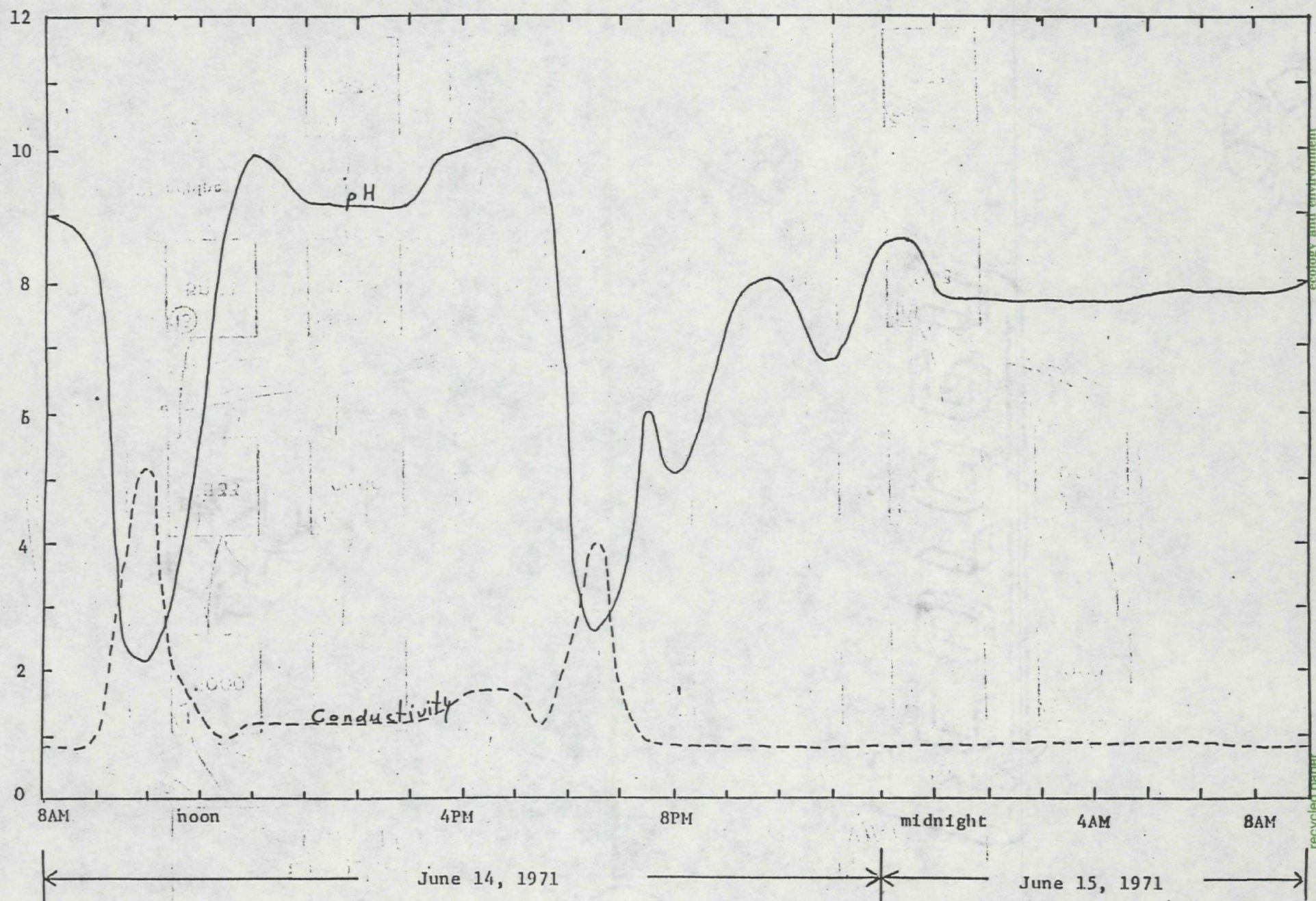
FIGURE 1: A SERIAL DILUTER DELIVERING EFFLUENT CONCENTRATIONS OF 8.33 TO 100.00%



• = Tube from Standpipe

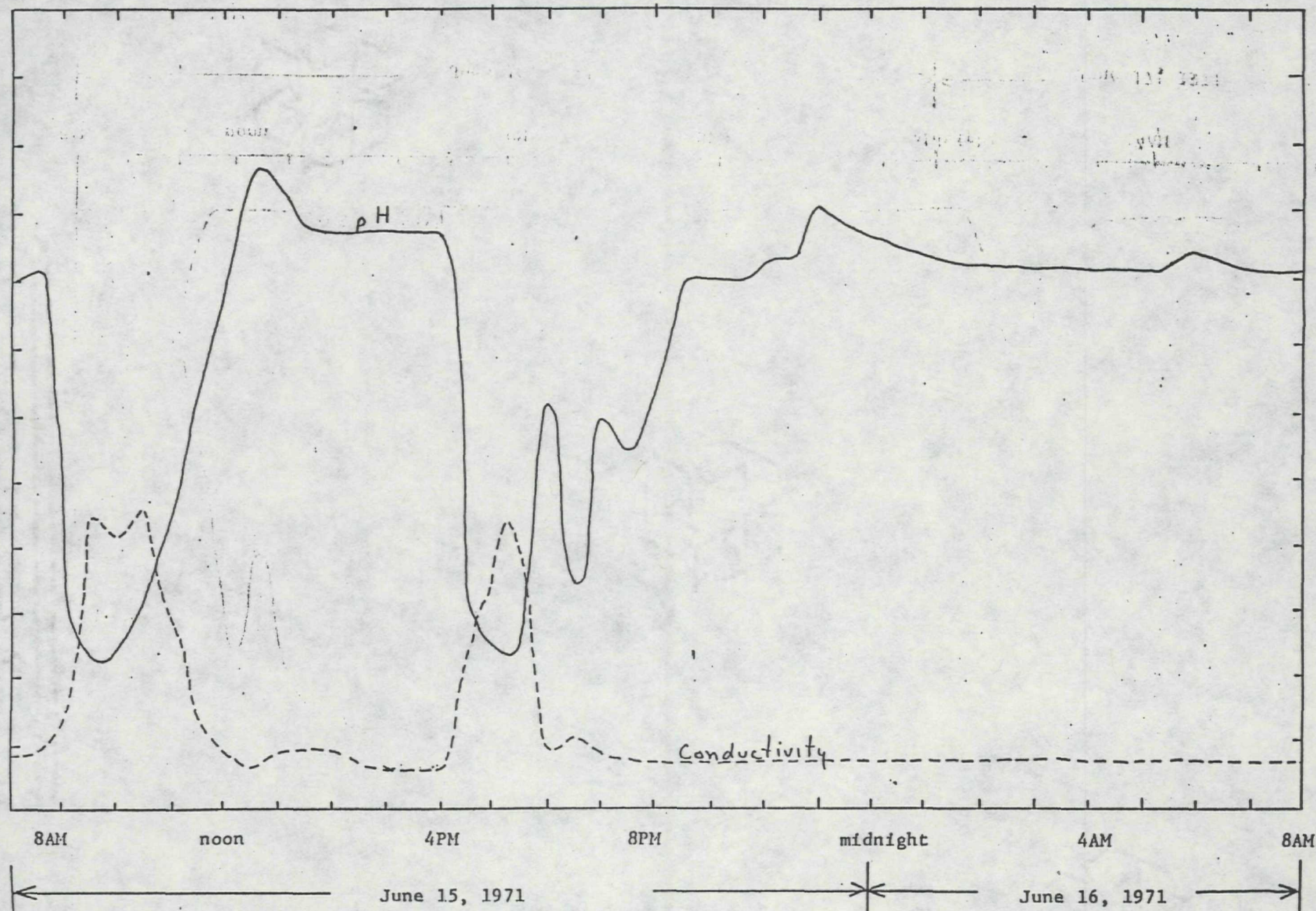
NOTE - All Figures Are Percent Effluent

Appendix 3. Water Quality data from the Pennwalt Chemical Company West Plant effluent.

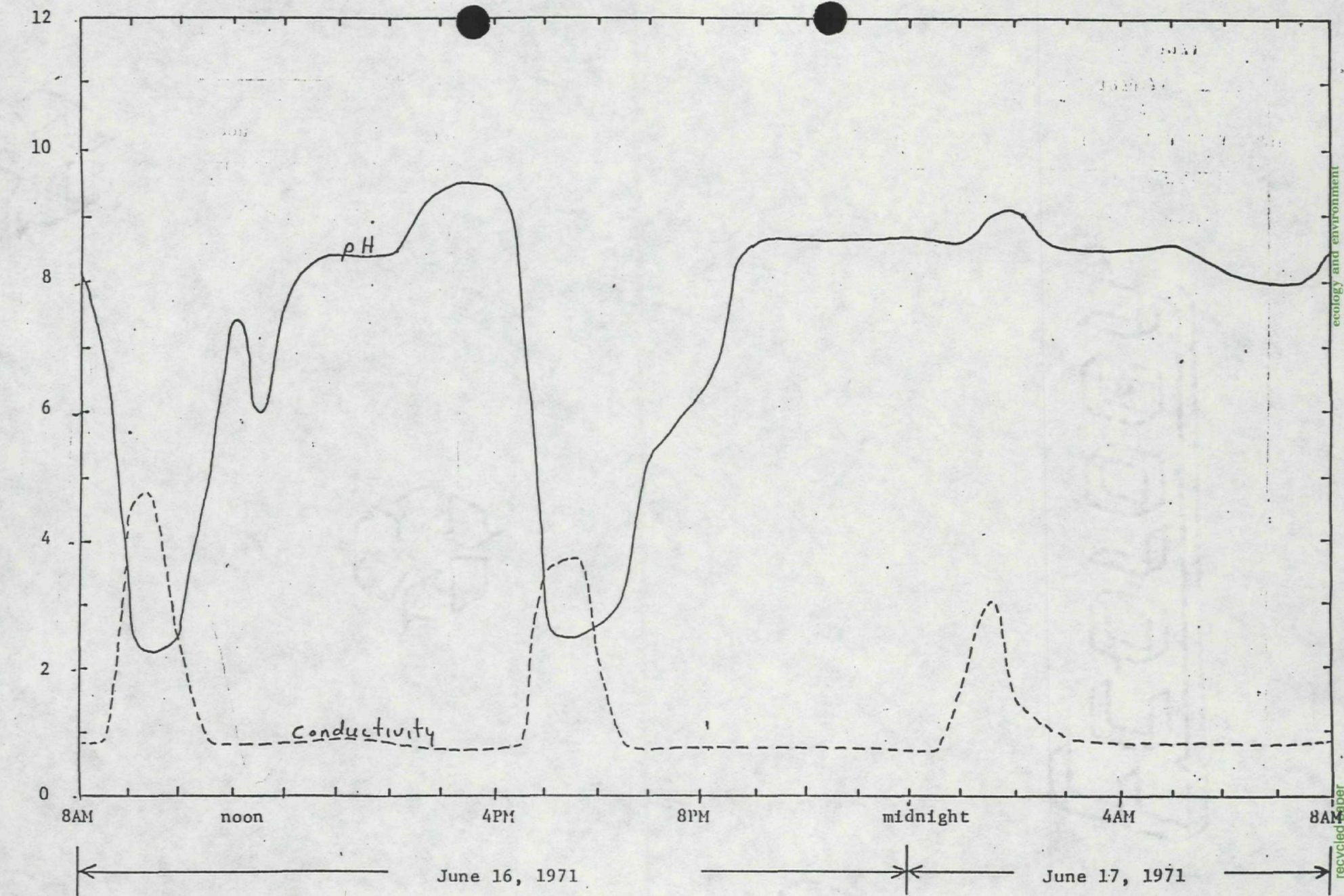


pH - read direct
Conductivity - x 500 μ mho

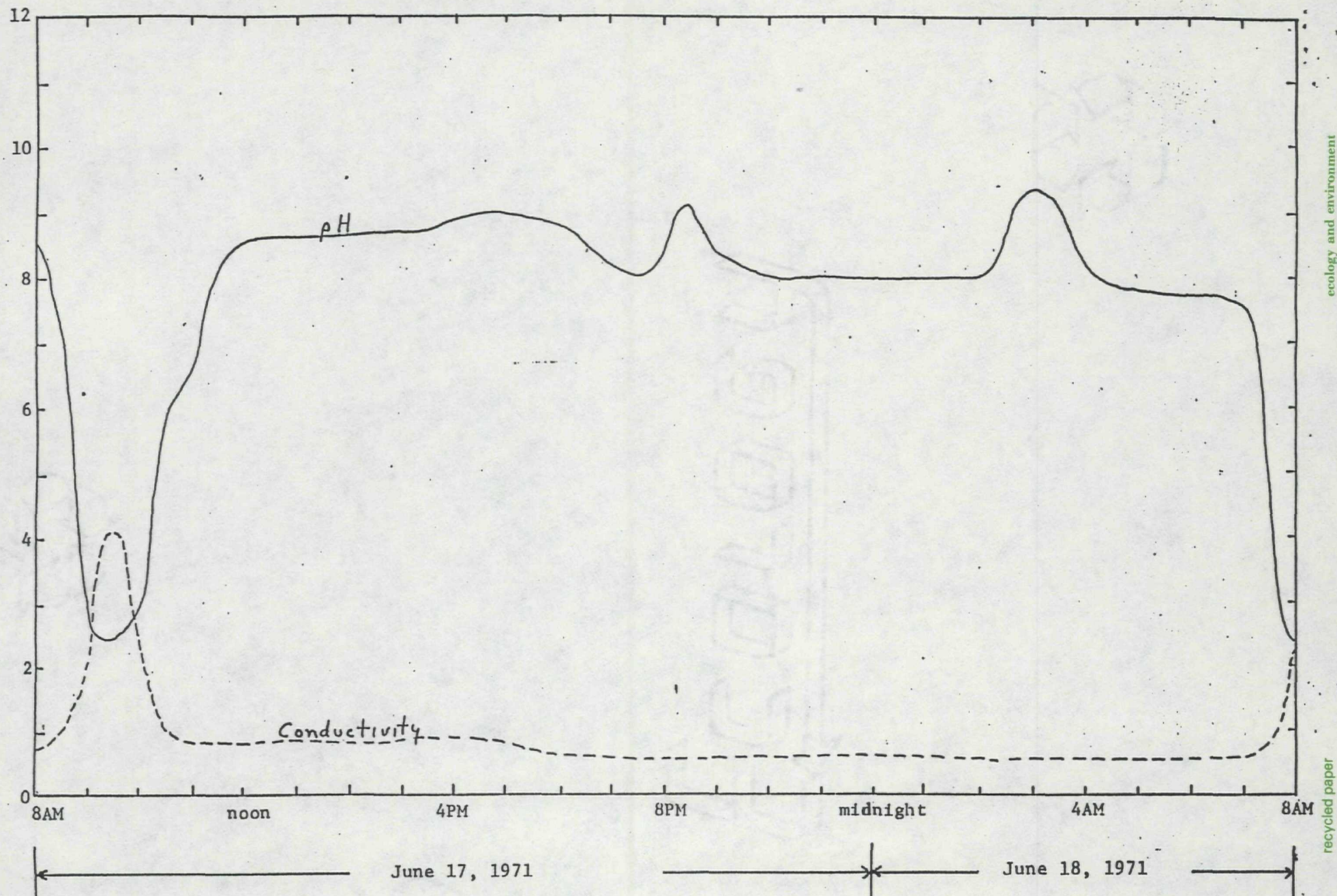
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pH - read direct
conductivity - x 500 μ mho



pH - read direct .
Conductivity - x 500 μ mho



ecology and environment

recycled paper

pH - read direct

Conductivity - x 500 μ mho